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CONTENTS OF No. 92.

	PAGE
A Naturalist's Year. Wasps and Flowers. By Grant Allen	65
The Morality of Happiness: Conduct and Duty. By Thos. Foster	66
The Chemistry of Cookery. XIV. By W. Mattieu Williams	67
Pretty Proof of the Earth's Rotundity. (*Illus.*) By R. A. Proctor	68
How to Get Strong	70
Pleasant Hours with the Microscope. (*Illus.*) By H. J. Slack	71
Niagara. (*Illus.*) By R. A. Proctor	72
Laws of Brightness. VII.	74
Discovery of the Chief Division in Saturn's Ring. By Capt. Noble	75
The Face of the Sky. By F.R.A.S.	77
Paradox Column: A New Theory of Copernicus	77
Correspondence	77
Our Mathematical Column: Geometrical Problems. X.	78
Our Chess Column	79

A NATURALIST'S YEAR.

By GRANT ALLEN.

XVIII.—WASPS AND FLOWERS.

ON the very summit of the wind-swept heath, scarcely sheltered from the north by a ragged row of straggling Scotch firs, a colony of broom manages somehow to battle hard for life against wind and weather, while on its roots the fat tuberous stems of the greater broomrape have fastened themselves vigorously to suck out whatever little sap the poor drained plants can spare, with all the ruthless, leech-like greediness of born parasites. Broomrape, we call the withered brown weed, in fact, in good old English, for this very reason, because it roots itself firmly on the underground stem of the broom, and violates or plunders it till almost nothing is left of it but bark and wood. It is a tall, wilted-looking thing, this broomrape, so dry, and grey, and faded, that you would hardly take it at first sight for a living flower at all; you would be much more likely to pass it by unnoticed as a sere and withered stalk covered with last year's empty seed-vessels. If you look at it closely, however, you will see that, though it is almost leafless, like most other thoroughgoing plant-parasites (having only thin stem-scales instead of green foliage) it is, nevertheless, a fresh, vigorous, and succulent living spike of dingy blossoms. At this moment, the spikes are all surrounded by belted black and yellow wasps, whom I have often seen hovering before around the dull flowers; for greater broomrape is a wasp-fertilised plant, though the fact seems to have escaped the observant eye even of that most patient and careful of German naturalists, Hermann Müller. Everybody knows, of course, the close connection that exists between bees and flowers; but I don't think most people are aware that there are a few exceptional plants which depend almost entirely upon wasps for the due conveyance of their pollen from head to head; so perhaps I can't do better than take this dingy brown broomrape for the text of a short discourse on this very subject, and point out how far the peculiar æsthetic tastes of the omnivorous wasps have reacted upon the special flowers on which they have concentrated their unconscious botanical efforts.

Wasps, as we have all observed, are very promiscuous feeders. They will eat almost anything they can get, from a good piece of raw beef to a plum or a potato. Hence, like most other promiscuous feeders, they have not acquired any marked taste for beauty of form or colour. As a rule, in the animal world, love of colour is found only among those birds or insects which restrict themselves entirely to honey-sucking in brilliant blossoms or to eating equally brilliant fruits. On the other hand, wasps are not wholly devoid of the flower-haunting habit; for they are very fond of sugar and all other sweets, as we have often noted both in grocers' shops and at our own dessert. So they seek for honey in a few special and peculiar blossoms, which have thus been compelled to adapt themselves to the very low tastes of these uncanny insect allies. Bees are fond of flowers with long tubes, which preserve the nectar from other thieving species; and in order to allure their fastidious eyes, such blossoms have acquired brilliant tints of purple, blue, or crimson, which are very attractive to the honey-loving aristocrats of the insect world. But the wasps care nothing for such beautiful æsthetic displays; they are strictly practical insects, with a decided eye to material advantages, and all they ask is that the flowers they patronise should not play at fox and stork with them, by concealing their nectar at the bottom of a long and narrow tube. Wasp blossoms, in short, must have shallow, open, cup-shaped corollas, just big enough to fit the insect's head, and with abundant honey so disposed that it can be readily abstracted without much trouble by the vespine mouth. They need not be bright-coloured; indeed, brightness of colour, by attracting other insects which are less adapted for fertilising them, would prove actually disadvantageous to the species; so as a class they are the very dingiest and dullest of known flowers, being specially modified, as has been quaintly said, "to suit the wants of an insect circle possessing very uncultivated æsthetic tastes." You could not have a better example of the group than that afforded us by this brown and dry-looking greater broomrape. It is inconspicuous enough to keep away all other insects; and those few venturesome flies that do venture near it, allured by the smell of honey, are sure to be quickly driven off by the sharp jaws and deadly stings of its natural possessors, the wasps.

We have not very many native wasp-flowers in England, but what few we have are quite sufficient to give us a very good general idea of the effects produced by such very special and exceptional selection. The commonest among them are the two fig-worts or scrophularias, which grow abundantly by the water's side. These very odd and uncanny blossoms are shaped so as just to form a hood or helmet for the wasp's head; and when he inserts his mouth into the flower, he rubs the pollen from the stamens last visited on to the forked and bent stigma with unerring certainty. In colour, the corolla of the fig-worts is an indescribable dirty olive brown, with a touch of chocolate red and green in it, not at all pretty, but extremely queer and noticeable. You can't stand by the side of one for five minutes without seeing it visited by at least one wasp, and on bright, sunny mornings you are pretty sure to see half-a-dozen. Another somewhat rarer English wasp-flower is the broad-leaved epipactis, an orchid growing in shady places, and not infrequent on the outskirts of moorland farms. In colour, it is almost the same dingy purplish-green as the fig-worts, and it is arranged so as to form a very similar hood-shaped cap, just fitting the wasp's head. So far as family goes, these two weeds are as wide apart as any two flowering plants can possibly be, for the one is a very advanced monocotyledon, while the other is a highly-modified type of dicotyledon; but their adaptive peculiari-

XUM

ties, developed by the selective action of the same wasps, are almost exactly similar. On the other hand, we have in England a second epipactis, confined to marshy situations, and in all essential particulars practically identical with the broad-leaved species; but it is fertilised by the honey bee, by certain flies, and by some other colour-loving insects, and therefore, instead of being dull purple or brown, it is prettily variegated with pink and white—being, in fact, one of our daintiest and most beautiful native orchids. This case admirably exemplifies the powerful influence of the insect guests on such easily-modified points as colour and dappling. Another wasp-flower which, though not exactly British, has been planted in our shrubberies and borders till it has become practically naturalised, is the snowberry, whose small, round, bell-shaped blossoms and pulpy white fruit are familiar to everybody. By descent the snowberry is a member of the honeysuckle family; but it has acquired the habit of being fertilised mainly by wasps, and it has adapted itself accordingly to their needs and requirements. Instead of a narrow deep tube like the true honeysuckle, beloved by long-tongued humming-bird hawk-moths, it has got a short, shallow, goblet-shaped corolla, exactly fitted for the accommodation of a wasp's head. In colour the flower is rather pinkier and prettier than the figworts or the greater broomrape, but then it is also more dependent for occasional chances upon other colour-loving insects. It has not yet completely specialised itself for wasps alone, and in some places it is almost equally visited by hive-bees. Lastly, I must not forget to mention the most famous wasp-flower of all, that of the edible fig, whose fruits cannot be properly set without the intervention of a closely-correlated insect ally, known as the fig-wasp. Figs are practically what is called in the technical language of botany, diœcious—that is to say, the stamen-bearing and seed-bearing flowers grow separately on distinct trees, for the female flowers are abortive in some cases, and the male ones in others. Only the female, or fruit-producing trees, are cultivated. The wild caprifico of Italy supplies the complementary males. The fig-wasps lay their eggs in the fruit of the caprifico, and there the young hatch out. Then the peasants hang the caprifico fruits on the fig-tree, so that the wasps, on flying out covered with pollen, may at once enter the young figs. The whole history of these wasps and the figs which they impregnate is a marvellously interesting one, but it is too long and far too complicated to enter into at full length here. It must suffice to note that the fig inflorescence is just as dingy green or dull purple as all the other known wasp-flowers.

THE MORALITY OF HAPPINESS.*

By Thomas Foster.

CONDUCT AND DUTY.

MORALITY relates to those parts of our conduct of which it can be said that they are right or wrong. Under the general subject conduct, then, morality is included as a part. Or regarding the word "duty" as implying all that we ought to do and all that we ought to avoid, we may say that duty is a part of conduct. All actions which are not purposeless may be regarded as included under the word "conduct," as well as some which, though purposeless at the time, result from actions originally done with purpose until a fixed habit had been acquired. But only those actions which we consider good or bad are referred to when we speak of duty; and the principles of what we call morality relate only to these.

Here, however, we have already recognised a connection between duty and conduct generally, which should show all who are familiar with scientific methods that morality cannot properly be discussed in its scientific aspect without discussing conduct at large. Every student of science knows that rightly to consider a part, he must consider the whole to which it belongs. In every department of science this general law holds, though it is not always recognised. No scientific subject has ever been properly dealt with until it has been considered in its relations to its surroundings as well as separately. Even in matters not usually considered from a scientific standpoint the same law holds. To go no farther than our own pages, the writer who is dealing with the question "How to get strong?" would not consider how the arms are to be strengthened without duly considering that the arms are part of the body, their exercise related to the exercise of other portions, their development associated with the development of other limbs, with the action of other parts of the body, with the regimen proper for the whole frame.

It may not by many be regarded as a *fault* of most systems of morality, that they overlook the necessary connection between conduct in general and conduct as guided by moral considerations. For, many are content to regard moral laws as existing apart from any of the results of experience—whether derived from individual conduct, the conduct of men generally, or conduct as seen among creatures of all orders. With many, morality is looked upon as a whole,—the whole duty of man—not as a part of conduct. They even consider that moral obligations must be weakened when their dependence on conduct in general is insisted upon. Moral rules, with them, are right in themselves and of necessity—and whether inculcated by extra-human authority, or enjoined by law, or perceived intuitively, are open neither to inquiry nor objection. Clearly if this were so, morality would not be a fitting subject for the scientific method. Its rules would be determinable apart from the discussion of evidence based on experience whether observational or experimental. I do not here inquire whether this view is right or wrong. Later on it will fall into my plan to do so. At present I only note that we are considering our subject from the standpoint of those who desire to view morality in its scientific aspect. For them it is essential that as conduct in general includes conduct depending on duty, the discussion of questions of duty cannot be complete or satisfactory unless it is conducted with due reference to the whole of which this subject forms a part.

If any doubt could exist in the mind of the student on this point, it should be removed when he notes that it is impossible to draw any sharply defined line between duty and the rest of conduct not depending on considerations

* I remind the reader that in these papers, as stated in the introductory one, I am following the lines along which Mr. Herbert Spencer has already traced the general doctrine of the morality of happiness. Where his reasoning seems open to objection or too recondite to be quite readily followed, I shall indicate such objections, and my own opinion respecting them, or endeavour to remove such difficulties, but the moral doctrine I am here dealing with is that of which he has been the chief teacher, if he may not be regarded as its only founder. Even if the scientific study of Ethics, on principles analogous to those which have made astronomy, geology, and more recently biology, true sciences, has been taken up by others and pursued till new truths have been recognised and perhaps some errors pointed out in his treatment of it, it remains still true that he was the first to indicate the true scientific method, and to show where hitherto it had been departed from even by the founders of the school of philosophy to which he belongs.

of duty. Not only are those actions which under particular circumstances seem absolutely indifferent ound under other circumstances to be right or wrong and *not* indifferent, not only do different persons form different ideas as to what part of conduct is indifferent or otherwise, but one and the same person in different parts of his life finds that he draws different distinctions between conduct in general and conduct to be guided by moral considerations. In the evolution of conduct in a nation, in a town, in a family, or in the individual man, the line separating conduct regarded as indifferent from conduct regarded as right or wrong, is ever varying in position,—sometimes tending to include among actions indifferent those which had been judged bad or good, oftener tending to show right or wrong in conduct which had been judged indifferent.

If moral laws, then, are to be established on a scientific basis, it is essential that conduct at large should be carefully considered; and not conduct only as it is seen in man, but as it is seen in animals of every grade. Thus and thus only can the evolution of conduct be rightly studied; by the study of the evolution of conduct only can the scientific distinction between right and wrong be recognised; from and out of this distinction only can moral laws be established for those with whom the authoritative enunciation of such laws has no longer the weight it once had, those who find no other inherent force in moral statutes than they derive as resulting from experience, and who reject as unreasonable all belief in the intuitive recognition of laws of morality.

We proceed then to consider the evolution of conduct in the various types of animal life from the lowest upwards to man.

THE CHEMISTRY OF COOKERY.

XIV.

By W. Mattieu Williams.

BEFORE leaving the subject of caramel, I should say a few words about French coffee, or "Coffee as in France," of which we hear so much. There are two secrets upon which depend the excellence of our neighbours in the production of this beverage. First, economy in using the water; second, flavouring with caramel. As regards the first, it appears that English housewives have been demoralised by the habitual use of tea, and apply to the infusion of coffee the popular formula for that of tea, "a spoonful for each person and one for the pot."

The French after-dinner coffee-cup has about one-third of the liquid capacity of a full-sized English breakfast-cup, but the quantity of solid coffee supplied to each cupfull is more than equal to that ordinarily allowed for the larger English measure of water.

Besides this the coffee is commonly, though not universally, flavoured with a specially and skilfully-prepared caramel, instead of the chicory so largely used in England. Much of the so-called "French coffee" now sold by our grocers in tins is caramel flavoured with coffee rather than coffee flavoured with caramel, and many shrewd English housewives have discovered that by mixing the cheapest of these French coffees with an equal quantity of pure coffee they obtain a better result than with the common domestic mixture of three parts coffee and one of chicory.

A few months ago a sample of "coffee-finings" was sent to me for chemical examination, that I might certify to its composition and wholesomeness. I described it in my report as "a caramel, with a peculiarly rich aroma and flavour, evidently due to the vegetable juices or extractive matter naturally united with the saccharine substance from which it is prepared." I had no definite information of the exact nature of this saccharine substance, but have good reason to assume that it was a bye product of sugar refining.

Neither the juice of the beetroot nor the sap of the sugar-cane consists entirely of pure sugar dissolved in pure water. They both contain other constituents common to vegetable juices, and some peculiar to themselves. These mucilaginous matters, when roughly separated, carry down with them some sugar, and form a sort of coarse sweetwort, capable by skilful treatment of producing a rich caramel such as I received.

I tested its practical merits by making an infusion of pure coffee of fine quality, dividing this into two parts, adding to one a small quantity of the caramel, and leaving the other half unmixed. I found the infusion greatly improved in flavour by the admixture, and recognised the peculiarity which characterises the coffee prepared by Gatti and his compatriots, whose numerous establishments are doing so much for the promotion of temperance in this country. The aroma of this particular caramel is peculiarly fine, and the greater part of it is soluble in boiling water; thus I was able to mix it by merely adding to the coffee as we add sugar.

I have used my best eloquence in trying to persuade the manufacturers to sell it separately, but have not yet succeeded. They seem to have had painful experience of the gastronomic bigotry of Englishmen who refuse to eat or drink anything that is not hallowed by the sanction of their great-grandmothers, unless it is surreptitiously introduced by means of some device approaching as nearly as possible to a commercial swindle.

Returning to the subject of frying, we encounter a good illustration of the practical importance of sound theory. A great deal of fish and other kinds of food are badly and wastefully cooked in consequence of the prevalence of a false theory of frying. It is evident that many domestic cooks (not hotel or restaurant cooks) have a vague idea that the metal plate forming the bottom of the frying-pan should directly convey the heat of the fire to the fried substance, and that the bit of butter or lard or dripping put into the pan is used to prevent the fish from sticking to it or to add to the richness of the fish by smearing its surface.

The theory which I have suggested (see No. 13, page 2) is that the melted fat cooks by convection of heat, just as water does in the so-called boiling of meat. If that is correct, it is evident that the fish, &c., should be completely immersed in a bath of melted fat or oil, and that the turning over demanded by the greased-plate theory is unnecessary. Well educated cooks understand this distinctly, and use a deeper vessel than our common frying-pan, charge this with a quantity of fat sufficient to cover the fish, which is simply laid upon a wire support, or frying-basket, and left in the hot fat until the browning of its surface, or of the flour or bread-crumbs with which it is coated indicates the sufficiency of the cookery.

At first sight this appears extravagant, as compared with the practice of greasing the bottom of the pan with a little dab of fat, but any housewife who will apply to the frying of sprats, herrings, &c., the method of quantitative inductive research, described and advocated by Lord Bacon in his "Novum Organum Scientarum," she may prove the contrary.

"Must I read the 'Novum Organum,' and buy another dictionary, in order to translate all this," she may exclaim in despair. "No!" is my reply. This Baconian inductive method, to which we are indebted for all the triumphs of

XUM

modern science, is nothing more nor less than the systematic and orderly application of common sense and definite measurement to practical questions. In this case it may be applied simply by frying a weighed quantity of any particular kind of fish—say sprats—in a weighed quantity of fat used as a bath; then weighing the fat that remains and subtracting the latter weight from the first, to determine the quantity consumed. If the frying be properly performed, and this quantity compared with that which is consumed by the method of merely greasing the pan-bottom, the bath frying will be proved to be the more economical, as well as the more efficient method.

The reason of this is simply that much or all of the fat is burnt and wasted when only a thin film is spread on the bottom of the pan, while no such waste occurs when the bath of fat is properly used. The temperature at which the dissociation of fat *commences* is below that required for delicately browning the surface of the fish itself, or of the flour or bread-crumbs, and therefore no fat is burnt away from the bath, as it is by the overheated portions of a merely greased frying-pan, and as regards the quantity adhering to the fish itself, this may be reduced to a minimum by withdrawing it from the bath when *the whole* is uniformly at the maximum cooking temperature, and allowing the fluid fat to drain off at once. When cooked on the greased plate, one side is necessarily cooling, and the fat settling down into the fish, while the other is being heated from below.

The bath-frying, of course, demands separate supplies of fat—one for fish, another for cutlets and other similar kinds of meat, a third for such goody-goodies as apple-fritters—a most wholesome and delicious dish, too rarely seen on English tables. I suspect that the prevalence of the greased frying-pan is the reason of its rarity. Cooked by this barbaric device, apples are scarcely eatable, but when thin slices are immersed in a bath of melted fat at a temperature of about 300° F., the water of their juice is suddenly boiled, and as this water is contained in a multitude of little bladder-like cells, they all burst, and the whole structure is puffed out to a most delicate lightness, far more suitable for following solid meats than soddened fruit enveloped in heavy indigestible pudding-paste. Another advantage is that with proper apparatus (wire basket, stew-pan, and store of special fat) the fritters can be prepared and cooked in about one-tenth of the time demanded for the preparation and cookery of an apple pudding or pie. A few seconds of immersion in the fat-bath is sufficient.

But the fat that has been used several times requires purification. This is especially the case with that devoted to fish-frying. The purification of fat is an important and interesting process that I will endeavour to treat as simply as may be in my next.

*** There is no Editorial Gossip this week for the reason that the Editor's medical adviser recommends cessation for the present from all work not absolutely necessary.

PRETTY PROOFS OF THE EARTH'S ROTUNDITY.

CHIEFLY FOR THE SEASIDE.

By Richard A. Proctor.

ALTHOUGH I suppose none of the readers of Knowledge entertain any manner of doubt as to the rotundity of the earth, it is not unlikely I think that some will find the illustrations or proofs of that rotundity which I propose to describe in this and a few following papers, somewhat novel. They have occurred to me during my residence at the seaside in former years and recently, and during my travels over prairie levels in North America, and so far as I know have not as yet found a place in text-books of astronomy. Just now when many readers of Knowledge are at the seaside these methods or some of them will be found especially interesting, since the sea-surface constantly illustrates terrestrial rotundity.

Let me premise that as commonly presented in works on astronomy the proof of rotundity afforded by the appearance of ships as they pass over the horizon limit and beyond, is apt to introduce a serious difficulty, though sound enough in itself. We are shown in a picture entirely out of proportion, a round hill of water over the top of which a line of sight is carried from an observer as at A, Fig. 1, a departing ship being shown in several positions as at 1, 2, 3, 4, fully seen at 1 and 2, hull down

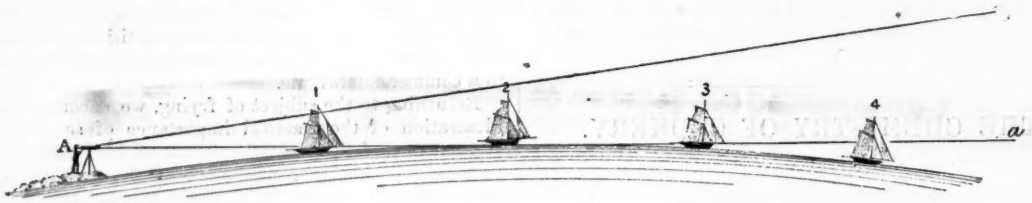

Fig. 1.

at 3, and showing upper part of mast only at 4 to the spectator at A. In such pictures the depression of the line of sight A*a* touching the convexity of the water, or the angle *a*A*t* which it makes with the horizontal line A*t*, is so considerable as to be obvious. Now the student is thus taught two things,—one true the other untrue. He learns correctly enough how and why a ship disappears beyond the convexity of the sea; but he is also taught what is not correct, viz. that the sea horizon dips observably below the true horizon, and that the depression of the sea horizon becomes obviously greater as the observer's height above the sea-level increases. When the learner is next at the sea-side and notes that there is no such visible depression, nay that when he is a good deal above the sea-level the sea horizon appears (by an optical illusion, indeed, but still very strikingly) higher than when he stood on the seashore, he is apt to think he has been wrongly taught on the other point also.

It was in this way indeed that the small but lively sect of flat-earth men were deceived by the man who under the pseudonym Parallax has borne—for reasons best known to himself—three surnames of more familiar sound, and to this day the peculiarity in question is the one by which his followers are deluded. It cropped up in the notorious Bedford Level experiment by which the wager respecting the rotundity of the earth was decided; and I fancy that to this day, on the strength of this misleading peculiarity the loser of that foolish wager considers that he was most hardly dealt with. The experiment actually made on that

occasion was neat and decisive enough; and *before* the experiment I have not a doubt the loser thought the trial could have but one result. It may serve as one among the "pretty proofs" now to be dealt with, while the delusive experiment which the loser wished to substitute after the matter was settled may also be considered with advantage.

On the Bedford level, where there is a water surface without bend for more than twenty miles, are two bridges as at A and C in Figs. 2 and 3, six miles apart, the water surface between them extending straight from A to C. Supposing the earth's surface plane the straight line A B C (Fig. 2) will correctly represent this water surface. On the other hand if the earth's surface is globular, A B C will be an arc of a large circle as in Fig. 3, the straight line A C falling as A *h* C.

Now at A a telescope was set up as at *t*, A *t* being a given length, say 10 ft. (it really matters not what the length so that the same lengths were used at all the stations). At B midway between A and C a pole of the same length was set up bearing a round disc as at *b*, B *b* therefore being 10 ft. On the bridge at C a disc *c* was set up at the same height of 10 ft. above the water surface. Thus A *t*=B *b*=C *c*=(say) 10 ft.

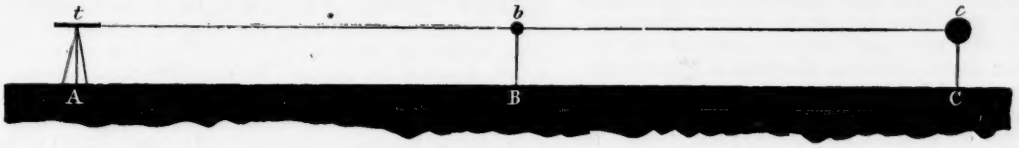

Fig. 2.

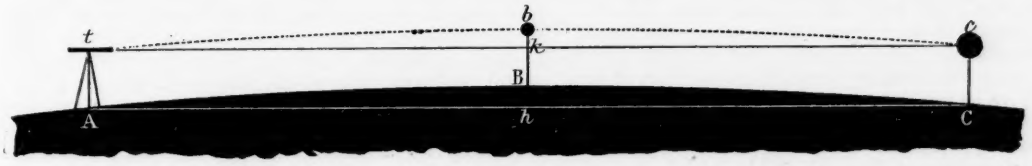

Fig. 3.

Fig. 4.

Now it is obvious that if, as in Fig. 2, A B C is a straight line, *t b c* is also a straight line; so that the telescope at *t* directed to the disc *c* bears also on the disc *b*. Thus if the earth flatteners were right *b* and *c* would lie in precisely the same direction from *t*, or the disc *b* if of the same size as *c* would centrally hide *c* from view.

On the other hand, if A B C is the arc of a circle, so is *t b c* the arc of a circle, of appreciably the same radius; so that the telescope at *t* directed to the disc *c*, does not bear on *b* but on a point *k* below *b*, where the straight line *t c* cuts *b* B.

Let us see what *b k* is, in order that we may see whether we have here a delicate or an obvious and very simple test. We have *t k c* a chord to a circle 7,920 miles in diameter, and *b k B h* produced is a diameter of this circle, bisecting *t c* in *k*. Hence we have by a well known property—

$$tk^2 = bk \text{ (earth's diameter} - bk)$$

or $(3 \text{ miles})^2 = bk$ (7,920 miles)

(for the *bk* within the brackets can obviously be neglected).

Hence $$bk = \frac{9}{7920}\text{ths of a mile.}$$

$$= \frac{9 \times 3 \times 1760}{7920}\text{ ft.}$$

$$= \frac{3 \times 1760}{880}\text{ ft.} \quad = 6 \text{ feet.}$$

It is clear then that the test is a very simple and obvious one. For supposing we have a disc 1 ft. in diameter at *b*, and a disc 2 ft. in diameter at *c*, so that seen from *t* both look equally large, it is obvious that the centre of the disc *c* will be seen 6 ft. below the centre of the disc *b*, or the appearance presented will be as at Fig. 4, the distance *e f* being five times *d e* or *f g* the diameter of either disc, while *b k* is six times *d e* or *f g*. And though in the telescope the scale on which what is shown in Fig. 4 would be seen may be very small, for a distance of 6 ft. is but small at three miles from the eye, yet the discs would show the displacement distinctly enough. As a matter of fact atmospheric refraction would diminish the distance *e f* by about one-fourth; but this would not affect the aspect of the discs. Manifestly the difference between a single disc such as would be seen if the water surface were plane as in Fig. 2, and the two discs separated by three or four times the apparent diameter of either, would be obvious, even to the eye of the most unpractised telescopist.

This then was a most suitable test, considering that neither of the bettors was an astronomer, and that the umpires were altogether without skill in telescopic work.

But when the observation had been made, and the disc at *b* had been seen well above the disc at *c*, the loser's umpire, and naturally the loser himself, began to doubt whether the test was right after all. *Could* it be right, to begin with, when it seemed to prove that the loser was wrong and that his money ought therefore to be handed over (as in point of fact it was handed over) by the stakeholder to the winner? No one who knows anything of paradoxical human nature can doubt what answer was given, by the loser, to this question.

The loser's umpire and the loser himself therefore suggested that the test ought to have been different. By some strange perversity they persuaded themselves that even though A B C were straight as in Fig. 2, *t c* should pass below *b*. *But*, said they, if the earth's surface is really curved, and therefore A B C an arc as in Fig. 3, the telescope at *t* must be depressed below the true horizon to point towards *c*, which is true enough; and therefore, if the telescope at *t* is made perfectly horizontal, by means of a level, *then* it would bear on a point above *c*; and if there is a point marking the centre of the telescopic field, *c* ought to be seen below that point. But having, as they assert, correctly and perfectly levelled their telescope, *c* was not found to be below the central point of the field marked by the intersection of two cross lines. The loser's umpire looked and saw *c* on the cross hair. The loser found it so too. They therefore not only denied the validity of the other test, but claimed

that the flatness of the water surface was proved and that the sum of £1,000 should be handed to the loser instead of to the winner according to the simpler test.

What they were really doing, only they did not know it, was proposing to substitute a very delicate and unsatisfactory test for a very simple and beautiful one; they were proposing in fact that the advantage given by the use of a mid signal at *b*, in adding to their instrumental means just what was necessary to make the experiment easy and decisive, should be given up, and a test at once difficult and indecisive substituted for it. This I propose to show next week.

(To be continued.)

HOW TO GET STRONG.

REDUCING FAT.

(Continued from page 50.)

IN passing let me note that those who are not troubled with undue adipose deposits need not imagine that therefore what is said here about reducing fat can have no interest for them. Most of the plans to which I refer are such as are good for those who wish simply to be strong in body. These methods depend on the avoidance of whatever overtaxes or weakens the system; and though the strong may be able to dispose of an extra amount of food or to resist influences which injuriously affect the weaker, they will be none the worse for following those rules by which the energies of the body are increased, or developed, or saved from being unduly taxed. Yet of course some parts of a system for reducing fat need not be followed by those who have no tendency or little to become obese.

After the food question considered in our last comes naturally the question of sleep which—like food—acts as a restorer of what Nature's wear and tear has removed.

In regard to sleep I take the same line as in regard to food. I consider it unwise to trust wholly or largely in wakefulness and want of rest to reduce fat. That to cut short the hours of sleep does tend to diminish fat is undoubted. The method is a very unpleasant one; but it is effective if one has but energy to follow it. Resolutely limit the sleeping hours to—say—the night hours between eleven and six, and certainly, if you have been in the habit of lying in bed till nine or ten, and perhaps taking a two hours' snooze in the afternoon, you shall find your weight diminishing. You lose weight because you are subjecting the body to a trying ordeal. Seven hours' sleep may be ample for most men, but the allowance is not ample for one who has fallen into the habit of sleeping daily nine or ten hours or more. Punish the body still more by depriving it of sleep and there will be more rapid reduction of weight. But there will probably be other mischief too. Besides, if a man has energy to apply this method, the most distressing of all fat-reducing systems, he can well adopt others, and he will assuredly do well to apply others to do part of the work of fat reduction.

Yet a share of the work can be left to this method—with great advantage all round. An undue amount of sleep is injurious in other ways than in encouraging the development of fat. It weakens the body, dulls the mind, and cuts away a considerable slice of life. Fat folk could not be wrong in steadily resisting and overcoming the habit, even though in so doing they did not—as they will—assist whatever other methods they employ for reducing their weight.

The first step in regulating sleep is to adopt regular hours for it. There should be a fixed time for going to bed and for getting up. Nature presently becomes accustomed to such hours, and then there is no lost time in bed. A man in average health should be asleep a few minutes after his head is on the pillow, and should wake a few minutes before the time which he makes his rising time. It is well to wait till these few minutes after waking have passed; though jumping out at the moment of waking may do very well when the habit of regular rising at a certain hour is first being formed. Immediately after rising it is well to fill a basin three-fourths full of cold water, and to plunge the face and fore part of the head in it several times till nearly out of breath. Recover breath and repeat the process. Again, and yet again. Then dry,—regular washing being attended to later. You are now wide awake, and able also to enjoy being so.

As to afternoon sleep, the rigid would say stop that at once. I do not agree with them. To a man who has fallen into the bad habit of sleeping after a midday meal, suddenly breaking the habit is very trying, and in my opinion mischievous. Careful observation has satisfied me that the evening is passed unpleasantly by one who has thus resisted a habit which though bad has become for awhile a part of his nature. The temper is tried; the sleep at night is not improved; and if after a week or two fat is reduced by this particular part of fat-attacking discipline, it is because the body is punished. One can get rid of fat and other mischiefs without punishing the system.

I would advise those who have fallen into the evil habit of sleeping in the afternoon, to resist each day for a time the heaviness which comes over them at the hour when they are accustomed to sleep. When the effort becomes painful, let them, instead of lying on a sofa or bed, sit comfortably in an arm-chair, loosing collar, cravat, and wristbands (also if necessary the waistband). Then let them sleep for about half-an-hour. I don't mean that they should give folk instruction to waken them, but that they should mentally resolve as they yield to the influence of sleep that it shall be but for half-an-hour or so. Without being wakened they will wake within a few minutes of the time. At least it will be so before long. Then let them stroll to bedroom or lavatory and repeat the face-plunging process as in the morning performance. They will be wide awake, yet all the better for the sleep. As time progresses the sleeping time may be shortened, and probably before long the afternoon nap altogether discarded.

It will be found that the change of diet both in quantity and quality suggested in our last will greatly help in giving mastery over sleep, especially over afternoon sleep. The active exercise advised in what follows may at first encourage the desire for sleep; but not long. By helping to make sleep sounder it will rather tend to shorten the sleeping hours in the long run.

We consider next, however, not exercise, but the treatment of the skin, on the condition of which the value of exercise in great part depends. Probably there is no surer and sounder system of fat reduction than that which is based on due encouragement of the healthy action of the skin.

(To be continued.)

Sun-Spots.—Mr. Slack writes that on the 22nd ult. [his letter was unfortunately forwarded to Ventnor, where, in consequence of a railway accident, the Editor was unable to go], in the afternoon, the sun's disk presented an extraordinary appearance; a succession of spots stretched nearly across it, most of them exhibiting a multiplicity of nuclei. There were also three spots isolated from the groups. With such a prodigious line of disturbance, any action which the spot condition may have upon the weather might be expected to be strongly marked.

XUM

PLEASANT HOURS WITH THE MICROSCOPE.

By Henry J. Slack, F.G.S., F.R.M.S.

IT is very common for persons unacquainted with entomology to suppose all the flies of somewhat similar aspect seen on a window-pane are the same sort; the big ones being taken for the grandfathers and grandmothers, and the least for their baby grandchildren. All insects, however, that pass through transformations such as common flies and butterflies do, reach their full size when they emerge from the chrysalis, and do not grow afterwards. Another common mistake is often made towards autumn, when "the flies" are accused of biting, the words implying a belief that the common house-fly gets vicious, or goes mad about that time of the year, which is not the case. Everybody must have noticed that when a house-fly settles upon any substance to feed, it puts forth a horse's head-like proboscis. This is a most wonderful apparatus, and a good way of commencing acquaintance with it is to assist at a bluebottle's dinner. To accomplish this, first catch your bluebottle and keep him under a pill-box or a wine-glass till his meal is ready. To prepare it, crush a bit of loaf sugar the size of a pin's head in a droplet of water. Take a little of the syrup thus made upon the end of a bit of wood—a lucifer match is just the thing—and smear it on the inner side of the glass cover of the live-box opticians usually supply with a microscope. Put the bluebottle upon it, and quickly shut him up by pressing the live-box into the rim of its cover, leaving the fly no room to turn over, but not squeezing him. The box is then placed on the microscope stage and the fly has his under side uppermost. It will soon begin to suck the syrup. The proboscis comes out of a cavernous cleft, the horse's-head end of it opens like two lips, which press against the glass, and the fluid is rapidly swallowed. If it is too thick, the fly can moisten and thin it. It can only swallow fluids, and the wonderful collection of tubes kept open by series of incomplete rings of a hard material act as filters to keep solid particles out. It would take a volume to describe the details of this wonderful apparatus, and no drawings can be made efficient substitutes for seeing the thing itself. The student should dissect such objects with needles set in wooden handles, fine scissors, and a fine, thin-bladed knife. It is also well to buy two slides made by a skilful preparer; one with the proboscis flattened out in the common way, and another mounted in fluid, and not squeezed out of its true shape. The insects can be fed with syrup tinged with cochineal, and the motion of it better seen. No examination of the house-fly or blow-fly will detect any apparatus adapted for biting or piercing a hard substance. In the middle of the proboscis are some teeth fit for scraping a material like moistened sugar, but no saws or lancets, or even knives capable of cutting.

On a hot day in the country, especially near cattle or horses, flies something like bluebottles and house-flies, but with elegantly-mottled wings and splendid green and bronze eyes, are sure to be found. These will take any opportunity of exercising their skill upon the hands or faces of human beings. They are furnished with a proboscis similar to that of the house-fly or bluebottle, and use it in the same way, but their delight is to suck the blood of the animal they torment, and to get at it they have tools to pierce a tough skin. If one of these flies is held in the hand by the wings, and the proboscis is gently poked with a finger-tip, some sharp tools will come out of a fold in its upper side. The males have four, and the females six implements. The latter will be found to possess a pair of Fig. 1, and another pair of Fig. 2, and one each of Figs. 3 and 4, which are pressed together to form a tube. A power of about 25 linear, obtained with an inch and a-half objective, will show the bluebottle at his dinner, and be sufficient to exhibit the form of the knives, &c., of the breeze-fly. A much higher magnification, say 500 linear, shows that an instrument (Fig. 1*a*), shaped like a carving-knife, or sword-bayonet, has its edge very fine and sharp, and the back, for more than half its length, very finely serrated, with the teeth set downwards. As it is pulled back out of a wound it would both enlarge and irritate it. The next tool (Fig. 2*a*) has teeth much like those of a coarse rasp, such as is used upon wood. This can act quickly upon the hides of an animal, and the great central tubular organ has teeth at the top, which a movement of partial rotation backwards and forwards must make a good piercer like a drill.

Fig. 1, × 25.

Fig. 2, × 25.

Fig. 3, × 25.

Fig. 4, × 25.

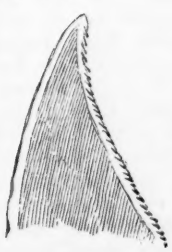

Fig. 1*a*, × 500.

Fig. 2*a*, × 500.

Fig. 3*a*, × 500.

All these instruments should be teased out with needles, and mounted in Canada Balsam. A fly's head, with these organs simply extended, should also be kept as an opaque object. Unfortunately the splendid eyes do not retain their colour, but while fresh are singularly beautiful when strongly illuminated.

To see the bluebottle using his proboscis or trunk, it must be lit up from above. A Lieberkuhn acts well, or a side silver reflector. Beck's is an excellent pattern; but the ordinary form answers well, and best if it is mounted on its own sliding stand and not made to fix on the microscope. Few spectacles are more astonishing than the quick nervous agitation with which the great lips open and shut, and the vigour with which they work.

XUM

The mouths of these flies exhibit remarkable departures from the most typical insect pattern, but the comparative anatomist regards their peculiar organs as modifications of simpler forms. Their mouths are called "*antliate*, with a fleshy proboscis (*labium*, or lip), and enclosing several lancet-like organs," so says Westwood of the Diptera in general, but it is only in certain genera that these lancet organs are adapted to hard work. It is instructive to compare the gnat's lancets and saws with those of the breeze-flies (*Tabani*), whose instruments are here figured, and their proboscis with the longer, and in every respect different one of the butterfly and moth. The most formidable of our insect enemies belong to the diptera, as that great group embraces mosquitoes, blow-flies, breeze-flies, gad-flies, &c., in this country, and also the terrible zimb, and the still more dreadful tsetse, whose bite produces a fatal disease in the horse, ox, sheep, or dog.

The modifications of mouth organs in various insects suggests a great lapse of time for their formation by the slow process of descent with modification, and the action of such a fly as the tsetse affords a striking instance of the immense series of changes that may spring from the peculiarities of one small creature. Take away all the animals which the tsetse will not allow to live, and not only is a great country rendered comparatively useless to man, but its vegetation must be different in many particulars from that cropped by herbivora, and manured by their excrements. The poison of the tsetse is very injurious to man, but not nearly so much as to the animals he most needs. Three or four of them are said to kill an ox, and yet the weight of the poison-drops they pour into their victim must be quite infinitesimal. The breeze-flies are not poisonous, but they sometimes attack human beings after their apparatus has been dipt in decomposing filth, and then serious sores result.

NIAGARA.

By Richard A. Proctor.

THE brave man who earned a world-wide fame by swimming Dover Straits and had earlier won an even nobler name by plunging into the Atlantic Ocean during storm to save (if so might be) a fellow creature's life, has cast himself a prey to the remorseless waters of Niagara. We cannot now, in the pain and horror excited by the terrible end of his mad attempt, speak as perhaps the stern moralist might speak, of the wrong Webb did his name and fame, the false example he set, by this last use of his splendid courage. We may well believe that he overrated his powers, and underrated (it would be impossible to overrate) the tremendous forces against which he proposed to contend. He maybe did not know, what a rough estimate of the energies at work in Niagara should have shown, that amid that mass of water which descends from the basin below the Falls to the engulfing vortex of the Whirlpool, the body of the biggest and strongest living creature must be as powerless as a drop of water in mid-Atlantic. We may well hope and believe that no weariness of the work of life led him to barter life, or ninety-nine hundredths of his life-chances, against the money by which those dependent on him might live in comfort. We learn that the American railway companies were guiltless, at the last at any rate, of the foul conduct imputed to them; and we may well hope that whatever was said of the sums Webb expected in reward of his exploit, he himself was moved only by the excitement of a contest with forces which other men deemed insuperable, but which he hoped to overcome. Let undue daring be held the only fault in the brave man we have lost. His example, so judged, though not free from blemish, will do little harm, compared at least with what it might have done had fear of life work moved him to his final exploit. Remembering that in his first and noblest achievement he was moved by no hope of gain or even of glory we may well believe that not ignoble thoughts but a lofty though unwise ambition stirred him to attempt the hopeless contest with Niagara in which his brave life was lost.

Lest others, fascinated as he seems to have been by the awful majesty of Niagara, should underrate the fearful power of the forces at work along the course by which the waters of Erie pass to Ontario, or deem that with better luck the Whirlpool Rapids might yet be passed with life—I venture to say a few brief words here about this marvel of nature.

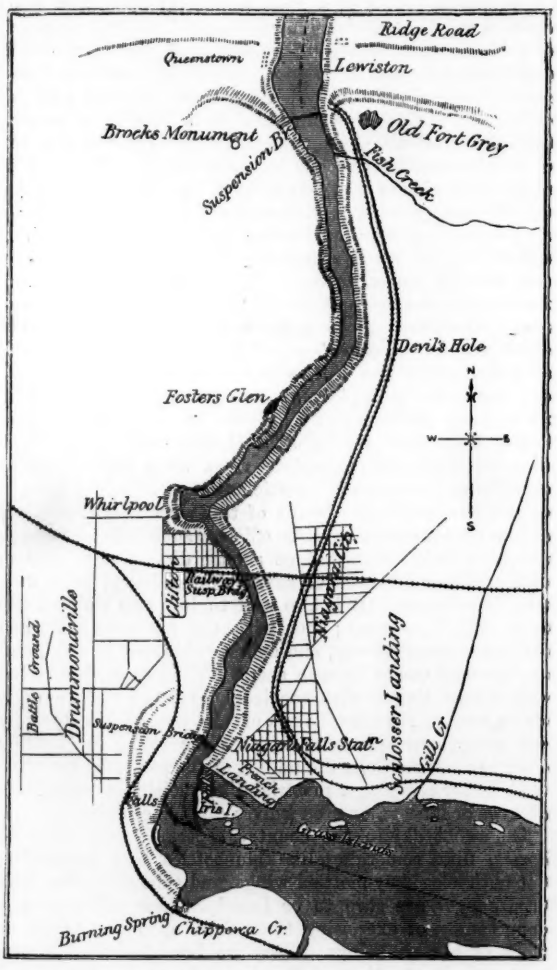

Fig. 1.—THE NIAGARA FALLS, RAPIDS, AND WHIRLPOOL.

The map (Fig. 1) shows the position of the Falls (the Horse-Shoe on the left the American on the right facing directly towards the west), the Whirlpool, and the Rapids,—the Upper Rapids between Iris Island and French Landing, the Lower Rapids between the Suspension Bridge

and the Whirlpool, the Whirlpool Rapids being those just above the Whirlpool itself. Fig. 2 shows in section, enormously exaggerated vertically, the descent from Lake Huron to Lake Ontario,—the River Niagara (Falls, Rapids, Whirlpool, and the quieter parts) being all compressed in this figure in the narrow space shown between Lake Erie and Lake Ontario.

Niagara is wonderful in this that here we have brought before us within a limited space the action of forces usually at work over a far wider area. In comparison with the forces of Nature actually at work in the earth, even during a single hour, the work done at Niagara in many years is almost as nothing. A small quantity of the waters gathered from the higher regions of a small portion of Northern America finds here an outlet, and passes from a level of no great height, by comparison with the elevation of even the smallest mountain ranges, to a height still considerably above the sea-level. Yet

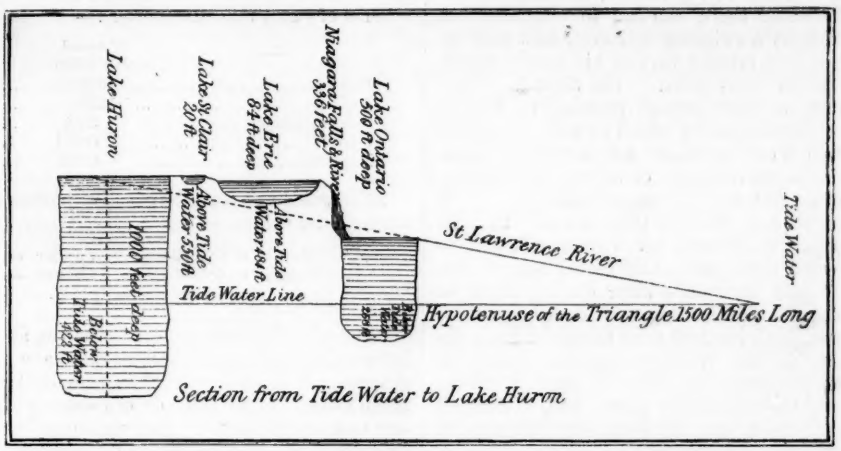
Lake Huron
Lake St. Clair 20 ft
Lake Erie 84 ft deep
Niagara Falls & River 336 Feet
Lake Ontario 500 ft deep
Above Tide Water 550ft
Above Tide Water 184 ft
1000 feet deep
Tide Water Line
St Lawrence River
Tide Water
Hypotenuse of the Triangle 1500 Miles Long
Section from Tide Water to Lake Huron

Fig. 2.—WATER SLOPE FROM LAKE HURON TO THE SEA.

because the range of distance within which the descent is accomplished is small, we have a display of nature's energies which impresses, even appals, the thoughtful mind, by presenting concrete evidence of the action of a force of whose might we have usually but abstract indications. To shallow minds Niagara is naturally disappointing, because they cannot even begin to comprehend its significance. To a dull mind the Atlantic and the Andes, the earthquake and the hurricane, are disappointing,—impressing it little more than they would impress a horse or a dog. But the mind which knows something of the language in which Niagara speaks, finds awful, almost oppressive, teaching in the thought that this work which goes on amid deafening uproar and confusing tumult represents not a millionth part of the energies residing in terrestrial gravity,—the force which our mother earth ordinarily uses as if but in play. Here its grim might is seen, and all the more impressively since we know that while it is but the merest nothing of the earth's force which is at work before us, yet we are overwhelmed by its vehemence, powerless in its presence. When the real energies of Niagara have been recognised, and the relation between these energies and the might of terrestrial gravity is understood, the mind must needs be awed, even oppressed, by the stupendous significance of Niagara. We pass from the grandeur of the scene displayed before us to the infinitely mightier terrestrial energies of which it speaks, thence to solar forces before which the whole might of earth is as nothing, and onwards to the starry depths where every point of light is such a sun as ours, until in the black darkness which hides from our eyes the real glories of the universe we recognise the mystery of Infinite Might unknown and unknowable: Lo! these are but a portion of God's ways: they utter but a whisper of His glory; the thunder of His power who can understand?

Professor Tyndall writes as follows in the *Daily News*:—"The 'rapids' proper of Niagara occur above the fall, where for a mile or so the water comes galloping and tumbling down before it takes its final leap over the ledge of the cataract. Below the cataract the river flows through a deep gorge, which has been excavated by the river. At some distance down there is a ferry between the American and the Canadian sides. Lower still is a suspension bridge for foot passengers, while about two miles below the fall the river is spanned by the railway suspension bridge. Between the ferry and this bridge, the river Niagara flows unruffled, but below the suspension bridge the gorge narrows, and the rapidity and turbulence of the water increase. For a certain distance the width can hardly be more than three hundred feet; and here occur what are called the 'Whirlpool Rapids,' which are not to be confounded with the rapids above the fall. It was through the Whirlpool Rapids that poor Captain Webb had to steer his way. It is impossible to describe the wild fury of the waters at this place. I send for your inspection a photograph by Bierstadt, which will give you some notion of it. The river boils and leaps in the most frantic manner, the most extraordinary effect being produced when two waves so coalesce that the united forces of both run on and toss the crest of the compounded billow, shivered into liquid spherules, high in air. In the middle of the river no man could live, and we are informed that Captain Webb avoided the middle. But the tossing everywhere is terrific. Lower down the river suddenly bends nearly at a right angle, and here is formed the whirlpool from which the Lower Rapids derive their name. The river strikes the bank opposed to it with tremendous force, and is thereby thrown into gyratory motion. Here, it is said, Captain Webb lost his life. I do not think a powerful swimmer, with his wits about him, need have come to grief in the Whirlpool itself. But how any man could have kept his senses intact amid the battering and tossing of the

Whirlpool Rapids it is difficult to imagine. It was probably the exhaustion of his power among the rapids that rendered the mighty swimmer unable to escape from the whirlpool. We shall doubtless receive the accurate account of the catastrophe in due time; meanwhile, the recitals in the English newspapers being more or less confused, I thought an approximately accurate description of the scene of the disaster might be of some interest."

Before the event, I wrote as follows in the *Newcastle Weekly Chronicle*:—"Captain Webb is more fitted than most men to battle with surging waves, more practised to maintain such actions as may give him the best chance of safety; but if he escapes his escape must depend on a lucky chance causing his body—necessarily inert to all intents and purposes throughout the beginning of his course—to be carried towards the whirlpool on the least dangerous course, and to be brought under the surface only at intervals enabling him to breathe. No one who has seen the Lower Rapids, and studied the movements of the water there, can fail to recognise that Captain Webb's skill as a swimmer will avail him scarcely anything except at one critical part of his course, which he may perhaps never reach alive. He himself clearly recognises the risks he runs, though probably he has no clear idea of the conditions under which he will be exposed to them. Captain Webb's personal action in the experiment will be akin to the influence of a drop of water on the movements of a great roller in the Atlantic."

The autopsy on Captain Webb's body showed that no bones were broken. There was no wound sufficient to cause death save one, three and a-half inches long in the cranium. This wound was made after death. None of the symptoms of death by drowning were revealed, and it was concluded that death resulted from the shock from the force of the water in the Whirlpool Rapids coming in contact with the submerged body with such force as instantly to destroy the respiratory power, and, in fact, all vital action. The shock was of sufficient intensity to paralyse the nerve centres, partially dessicate the muscular tissues, and forestall death by drowning.

On the Hamburg tramways a number of cars with flangeless wheels, much like omnibuses, and with turning gear, are working. To run on the lines, these cars are fitted with a shaft in front of the front wheels, this shaft carrying on a lever a disc wheel which the driver can lower into the tramrail groove as he requires, or raise it when it is necessary to get out of the way of obstructions. The arrangement works well, saves a lot of trouble, and the cars run easier than those with flanged wheels.

Messrs. Lamplugh & Brown, the well-known saddlers of Birmingham, have recently brought out a new tricycle saddle, which will be preferred by a number of riders to any other saddle at present in the market. The leather is suspended from the opposite ends of the saddle, and supported by a strong, flat, spiral spring, the tension of which can be altered to suit the rider's weight, while ventilation is provided far more efficiently than in any other saddle. The leather seat is slightly cushioned, so as to provide a soft surface to sit upon. At the back of the saddle there is a small upright nickelised support, and in place of the usual back-rest there is attached to this a solid cyclists' wallet, which answers the double purpose of forming a flexible back-rest for the rider and holding the tools, oil-can, or any other small necessaries required on a tour. The whole of the saddle is most ornamental in appearance, and is tastefully got up as well as excellently made.

LAWS OF BRIGHTNESS.

VII.

By Richard A. Proctor.

Zöllner carefully observed the brightness of the superior planets in mean opposition. His results are as follows:—

		Prob. error per cent.
Sun =	6,994,000,000 times Mars	5·8
Sun =	5,472,000,000 times Jupiter	5·7
Sun =	130,980,000,000 times Saturn (without rings)	5·0
Sun =	8,486,000,000,000 times Uranus	6·0
Sun =	79,620,000,000,000 times Neptune	5·5

It follows that, if the total brightness of Mars at mean opposition is set at 1,000, as in my former table, we have the following relative total brightness for the several planets as observed, and as calculated for the case of smooth spheres of equal reflective power:—

	Observed Brightness.		Calculated Brightness.
Mars	1000	...	1000
Jupiter	1278	...	487
Saturn, without rings	53·4	...	24·5
Uranus	0·824	...	0·30
Neptune	0·088	...	0·058

Zöllner deduces for the reflective powers of these planets' surfaces the values—

Mars = 0·2672 Jupiter = 0·6238
Saturn = 0·4981 Uranus = 0·6400
Neptune = 0·4648.

Zöllner's observations of the moon at different phases between the two quarters and full have next to be considered. It is obvious that as the different parts of the moon's disc, when "full," do not shine with the brightness due to a smooth surface, we might expect to find her total brightness at any other phase differing markedly from the value estimated for the case of a smooth sphere. This Zöllner found to be the case. The "full" moon is far brighter, by comparison with the gibbous moon (especially when little more than half full) than the relation illustrated in Fig. 10 would indicate. This relation is thus given by Lambert for the moon assumed to be a smooth sphere. Let v be the angular distance of the moon from the sun, then the moon's total brightness varies as

$$\text{sin. } v - v \text{ cos. } v$$

After carefully analysing the whole subject, discussing various hypotheses as to the moon's surface-contour, and "averaging" as only a German philosopher can do, Zöllner treats the case finally, as though the moon were covered with hills having a slope of 52° (it is not easy to follow him on this point, for his formula does not correspond to the case of conical hills, or prism-shaped hills, or, in fact, hills of any shape with such a slope). But Zöllner is led finally to substitute for Lambert's formula the following:—The moon's brightness, when she is separated by an angle v from the sun varies as

$$\text{sin. } (v - 52^\circ) - (v - 52^\circ) \text{ cos. } (v - 52^\circ).$$

This formula cannot, of course, be actually correct, since the expression vanishes when $v = 52^\circ$, whereas we know that the moon's brightness is not zero when she is 52 from the sun. As an empirical formula for the moon's brightness when she is gibbous, however, it serves well, as will be seen by the following table (where the brightness of the full moon is taken as 100):—

v	$\pi - v$	Calculated Brightness. Lambert's Formula.	Calculated Brightness. Zöllner's Formula.	Brightness. Zöllner.
°	°			
179	+ 1	99·98	98·60	98·60
185	5	99·63	92·79	87·20
172	8	99·06	88·41	92·19
169	11	98·24	84·04	88·76
193	−13	97·57	81·21	82·60
161	+19	94·93	72·29	68·41
156	24	92·13	65·15	71·38
153	27	90·18	61·00	57·90
207	−27	90·18	60·93	63·47
152	+28	89·53	59·60	56·15
208	−28	89·50	59·60	57·00
147	+23	85·82	52·90	48·60
219	−39	80·87	45·00	41·70
140	+40	80·04	43·72	47·10
139	41	77·78	42·50	43·95
222	−42	78·27	41·40	38·00
134	+46	74·61	36·70	36·10
232	−52	68·87	27·63	29·11
122	+58	62·91	24·30	27·10
242	−62	58·89	20·60	20·40
249	−69	51·82	15·20	14·60

It is remarkable that Zöllner's observations should agree so well with calculations based on a formula which is, on the face of it, erroneous.*

Zöllner's work on the brightness of Mars when gibbous led to the strange result that the defalcation of the brightness of Mars when gibbous is greater than in the case of the moon. Instead of an inclination of 52° for the Martian mountains, Zöllner inferred an inclination of more than 75°. It must be admitted, I think, that this would be absurd, even though we had reason to believe that the whole surface of Mars is solid, which is certainly not the case. An equally complete, and much more natural explanation, is obtained, if we suppose the Martian air to be ordinarily somewhat cloud-laden, the clouds resembling in shape our own summer clouds, and lying far enough apart to show the Martian surface. This explanation is given and illustrated at p. 65 of my "Essays on Astronomy," where it is shown that as a consequence of the supposed state of things the edge of Mars's disc should appear brighter than the central part, which is actually the case. But I must here note that there is a mistake in what I there say, to the effect that Zöllner's observations would be equally well explained by supposing that "when the sun is near the horizon of Mars, heavy mists hang in the air." The aspect of Mars when gibbous at once negatives this subsidiary explanation (as I ought to have noticed when I penned the above words, and as I should have noticed if I had followed my usual rule of reasoning out the matter at the time of writing). For, near the terminator of gibbous Mars the light darkens perceptibly, precisely as it should do if my first explanation be correct (of which I now entertain no doubt); but if morning and evening mists prevailed in Mars, the part near the terminator would be rather brighter than the part near the true limb. Comparing this with my reasoning as to the first explanation, and noting how absolutely untenable is Zöllner's theory of sugar-loaf hills all over Mars, it appears to be as nearly demonstrated as the nature of things renders possible that the Martial clouds are for the most part cumulus clouds.

(To be continued.)

* This table is taken from Klein's "Das Sonnensystem." In the original paper by Zöllner the logarithms of the quantities above tabulated are given, and Klein has been at great pains to substitute the natural numbers. But he fails to notice two mistakes in the original tables, where, opposite 139° and 219°, Zöllner sets as the logarithm of the brightness calculated by Lambert's method, 1·9985 and 1·9774 respectively, instead of 1·8985 and 1·9079 respectively. Thus in Klein's table there is given opposite 219° the value 94·93, and opposite 139° the value 99·66 which are obviously erroneous. Here is another instance of *the absolute necessity of examining everything resembling a table* which one may desire to make use of. No one would believe how readily mistakes will escape the notice of even the most careful tabulist. I am satisfied that the very care taken by Klein to make his table instructive caused him to overlook points affecting its general accuracy. It would be unfair not to point this out. There are two ways in which tables may become erroneous:—First, when tables are simply pitchforked into a book by a compiler, one may be tolerably certain that they are erroneous; but secondly, when a careful worker like Klein really gives labour to a table, it will happen that while engrossed on such special work, he overlooks the necessity for general supervision.

THE DISCOVERY OF THE CHIEF DIVISION IN SATURN'S RING.

MISLED by a categorical statement on page 217 of Breen's "Planetary Worlds," I last autumn wrote to KNOWLEDGE (Vol. II. p. 294) to inquire whether a letter written by Wallis to Huyghens, on the subject of the supposed duplicity of Saturn's Ring, was still extant, and, if so, where it was to be found. It was subsequently pointed out by Mr. Herbert Rix (p. 471) that it was not Wallis at all who wrote to invite the attention of Huyghens to what had been seen (or imagined) by William Ball, but the first President of the Royal Society, Sir Robert Moray. I am happy to learn, through Mr. C. Leeson Prince, F.R.A.S., that Moray's letter to Huyghens has been found in the library at Leyden by Dr. Bakhuyzen. The wording of this letter seems to me to be conclusive as to the idea which its writer entertained of the nature of the duplicity of Saturn's Ring, assuming it not to be a single appendage. "Quant au plus éloigné," says Moray, ("la planète Saturne) il y aurait plaisir à découvrir que son corps tourna autour de son axe pendant que ses anses demeurent ferme, et si c'est un cercle comme vous avez prouvé qu'il *pouvra bien estre* sans difficulté il ne pouvra avoir aucun mouvement autour du corps du planète si ce n'est qu'il garde tousiours une même plaine. Mais il est temps que vous considerez avec grande attention la figure de ces anses à présent pour voir si vous n'y voyez rien qui vous fasse avouer que ce n'est pas un corps de figure circulaire qui embrasse la disque du planète, mais deux; ce qu'il y aura quelque (word undecipherable) de croire à ce qu'il me semble selon les observations qu'en ont fait le Dr. Ball et son frère tous deux de nostre société, avec un fort bon télescope de 36 pieds." Hence it would seem that Moray was not quite convinced by Huyghens' reasoning that the ring of Saturn was a circle; but rather imagined that each of the ansæ was a separate curve, as shown in the strange drawing—or paper-cutting—by Ball, reproduced in Vol. I. of the "Philosophical Transactions" for 1665 and 1666, and engraved in fac-simile on p. 307 of your second volume. At any rate, it is obvious that neither Ball nor he had the most distant idea that Saturn was surrounded by two *concentric* rings. In the communication from which I have made the above extract, Dr. Bakhuyzen goes on to intimate that Joseph Campani may possibly have seen the outer and inner rings of Saturn, and even "traces of the inner dark ring," and he refers to a figure of the planet by Campani, in justification of this surmise. Mr. Prince, however, has this engraving in one of the numerous early astronomical volumes in his library, and he informs me that no indication whatever of a division in the ring exists in it. So far, then, I would venture to suggest, every attempt to deprive Cassini of the merit (*quantum valeat*) of having

been the first to see the chief division in the Saturnian Ring-system, has broken down utterly.

William Noble.

[I venture to add that in my opinion Captain Noble's conclusion is fully justified by the evidence.—R. P.]

For a long time past actions have been pending between Mr. Bown, of Æolus ball-bearing fame, and various bicycle and tricycle makers. The action against Messrs. Humber, Marriott, & Cooper was concluded on Monday, the 19th inst., and resulted in a verdict for the defendants, Messrs. Humber & Co., with costs. The judge decided in their favour without calling on their counsel to speak. Evidence was produced that three machines had been made and sold with ball-bearings on them similar in construction to Bown's, before the date of Mr. Bown's patents. The decision in this case is likely to prove very important. Many makers will be able to turn out machines at a lower price when they are no longer compelled to pay a royalty on the ball-bearings.

Size of Atoms.—Sir W. Thomson, in a discourse recently delivered before the Royal Institution, has presented the various lines of reasoning which have enabled physicists to estimate the size of molecules. The result has been already made known, but is worth repeating. By four lines of argument it is shown that—with a very high degree of probability—in any ordinary liquid, transparent solid, or seemingly opaque solid, the average distance between the centres of contiguous molecules is less than the 1-5,000,000th of a centimètre, and greater than the 1-1,000,000,000th of a centimètre. Expressed in relation to our more familiar measure the inch, this may, without science even, be represented by saying that the distance in question is less than the 1-2,000,000th of an inch and greater than the 1-400,000,000th part of an inch. If a globe of water or glass, 16 centimètres or 6 1-3 inches in diameter, were magnified to the size of the earth, each constituent molecule being magnified in the same proportion, then the magnified mass would be more coarse-grained than a heap of small shot, but probably less coarse-grained than a heap of 16 centimètre (or 6 1-3 inch) globes.

Newspaper Science.—The following remarkable paragraph appeared in last week's *Electrician*:—The intelligence of the press on technical matters in this country is on a par with that of a baby on soft soap. As soon as an exhibition opens the various papers commence to "report," but the peculiarity remains that the same errors run through scores of reports. One such error in matters electrical is now going the round of the press. We could, if we chose, point out the paper in which the error was made, but it would be impossible to point out the score or so of papers who have faithfully copied the error. Is the Leeds Forge Company's exhibit at the Metal Trades Exhibition lighted by a "storage," or by a primary battery? The papers say it is from a storage battery, and is as successful as it is pleasing in effect, and the result shows the progress made towards independent house lighting from storage batteries. We shall be glad to hear of the firm that claims this storage battery. The lighting may be successful, may be pleasing, may, indeed, be perfect, but whose is the storage battery? We are prepared to maintain, and we think we can prove, that not 5 per cent. of those who report exhibitions ever see the exhibits. [Our opinion of newspaper science is not high, but we feel convinced that the estimated percentage of dishonest reports is exaggerated.]

GREATEST CONTENT WITH PARCELS' POST.

By Richard A. Proctor.

THAT the new postal arrangements for parcels' delivery have given the greatest content to every British citizen is generally admitted. But I wish now to consider greatest content of another sort. The method of measuring parcels by the new delivery suggests a neat though simple little problem for the solution of which I propose to use the Differential Calculus,—to wit, what is the greatest content of a parcel which can be sent by post.

It is well known of course that if a cylindrical solid has a given height and girth the content will be greatest if the solid is a right circular cylinder. This can easily be shown geometrically. What we have to determine then is this,—Given the sum of the height and girth of a right cylinder, what is its greatest content.

Let h be the height, r the radius of the base, so that the given sum, the length of the measuring tape suggested in the postal directions $= h + 2\pi r = l$ say. Thus $h = l - 2\pi r$. Then

Content of cylinder $= \pi r^2 h = (l - 2\pi r)\ \pi r^2 = \pi\ (lr^2 - 2\pi r^3)$

Differentiating this expression with respect to 0, and equating to zero, we get $\pi(2rl - 6\pi r^2) = 0$

or $l = 3\pi r$

wherefore $l - 2\pi r = \pi r$; *i.e.*, $h = \frac{1}{2}(2\pi r)$

Thus the greatest content with parcels post, is given when the height of the cylindrical parcel is equal to half the girth. This makes the height of the cylinder, or what would usually be the length of our parcel, equal to 2 ft., for greatest content, and the girth equal 4 ft., making the radius of the base 2 ft./π. Putting $\pi = 22/7$ this gives radius of the base 7/11ths of a foot, the diameter 14/11ths or $15\frac{3}{11}$ inches, and length 24 inches.

If the parcel is to be a parallelopiped the shape which will give the greatest content may be thus determined:—

Of course the section perpendicular to the length must be a square; let the side of this square be a. Then the total length of the measuring tape being l, the length of the parcel is $l - 4a$; and the content is $a^2(l - 4a)$.

$$a^2 l - 4a^3.$$

Differentiating this expression with respect to a and equating to zero, we have—

$$2la - 12a^2 = 0$$

$$a = \frac{1}{6}l$$

$$\text{Thus the girth} = \frac{2}{3}l, \text{ or 4 ft.}$$

The parcel therefore must be 2 ft. in length or height, and 1 ft. in breadth and thickness, or have a section 1 ft. square.

The greatest solid content, then, by the new system is 2 cubic feet, for a flat-sided parcel. The actual maximum content is given in the case of the cylinder, the content of which is $\frac{1}{2} \times \frac{7}{11} \times 4 \times 2 = \frac{28}{11} = 2\frac{6}{11}$ cubic feet.

Taking the average amount of organic impurity contained in a given volume of the Kent Company's water during the nine years ending December, 1876, as unity, the proportional amount contained in an equal volume of water supplied by each of the metropolitan water companies and by the Tottenham Local Board of Health during May last was:—Kent, ·9; Colne Valley, 1·0; Tottenham, 2; Chelsea, 2·1; New River, 2·1; Grand Junction, 2·6; East London, 2·9; West Middlesex, 3·0; Southwark, 3·2; Lambeth, 3·6.

THE FACE OF THE SKY.

FROM AUGUST 3 TO AUGUST 17.

BY F.R.A.S.

A PERIOD of seemingly renewed solar activity renders the study of the Sun's surface very interesting just now; and no clear day should be allowed to pass without directing the telescope to his face. A representation of the night sky during the next fourteen days will be found in Map VIII. of "The Stars in their Seasons." Mercury sets after the Sun during the whole of August, and may possibly be caught with the naked eye over the W. by N. part of the horizon before 8 p.m. Venus is, for our present purpose, invisible. Mars rises before midnight half way between the N.E. and the N.E.-by-E.; but he only looks like a bright red star. Jupiter will not come into view until later. Saturn, though, rises between 11 and 12 p.m. during the earlier part of our specified period, and between 10 and 11 p.m. during the latter part of it. His ring is now so open as to be discernible in a comparatively small telescope. Between the 9th and the 11th of August, and notably on the night of the 10th, the Earth passes through a stream of those curious meteorites which become visible to us on entering our atmosphere as "shooting stars." Their apparition on the 10th gained for them the appellation of St. Lawrence's tears. They are now less poetically, but more scientifically, known as the Perseids, from the fact of their paths all seeming to radiate from a point in the constellation Perseus, forming a triangle with η and γ in that constellation. As a rule, they leave more or less marked trains of light in their wake. The most remarkable thing in connection with this stream is, however, the fact that it travels in the orbit of a small comet (II.) discovered in 1862. Unfortunately, it will be moonlight during the earlier part of the night of the 10th, but not during the whole of it. One occultation of a star by the Moon only will be observable during the fortnight covered by these notes. It will occur on the evening of August 15, when the 5½ mag. star ρ^2 Sagittarii will disappear at the Moon's dark limb at 7h. 25m., at an angle of 49° from her vertex, reappearing at her bright limb, at a vertical angle of 297°, at 8h. 32m. p.m. The Moon's age at noon on August 3 is 0·4 days, and quite obviously, 14·4 days at the same hour on the 17th. She leaves Cancer about 4 o'clock this afternoon, and passes into Leo, where she remains until about 2 p.m. on the 4th, at which time she crosses into Sextans. She takes until noon on the 5th to travel through this, and then re-enters Leo, which she finally quits at 2 p.m. on the 6th for Virgo. It occupies her until noon on the 10th to traverse this great constellation, and at that time she passes over the boundary into Libra. There she remains until about 1 a.m. on the 12th, when she enters the northern part of Scorpio. It takes her about 13 hours to traverse this, and then at 2 p.m. on the 12th, we find her in the southern part of Ophiuchus. Across this she travels, and enters Sagittarius about 8 a.m. on the 14th. She does not reach the confines of Capricornus until 6 p.m. on the 16th, and at 10 o'clock the next morning moves into Aquarius. We there leave her.

Paradox Column.

[The following certainly seems worthy of a place in this column. —R.P.]

A NEW THEORY OF COPERNICUS.

TO MR. R. A PROCTOR ASTRONOMER

SIR. It appears you are estimated to be a star of the first magnitude in astronomical circles. therefore I beg to introduce to you a few practical proofs that the Copernican theory is the greatest. because the most popular delusion under the sun. being by trade a carpenter I know what a true triangle is. I have also had some experience in leveling building by the horizon of the sea. which by a long straight ridge of a building may be seen to be perfectly straight and level for at least 30 miles. therefore. Can you explain the mystery How it is possible if the earth were a globe 8,000 miles in diameter. for the visible horizon to present an unmistakable straight and level line for 30 or 40 miles. and at the same time be sufficiently convex in 20 miles to hide from view the top masts of a ship some of which is no less than 140 ft high. ? Do the sea rise 140 ft in the centre of 20 miles. ? if so How can 30 miles of sea be a straight line. ? There is also a mystery respecting the supposition distance of the sun from the earth. Do the rays of the sun shine forth direct from the sun to the earth. if not. Can you explain what prevents their doing so. ? But. if the rays come direct. the visible oblique line of the sun's rays. testifies that the now popular supposition distance of the sun from the earth is more than 94.996-000. miles distance from the truth. which is truly a distance of no mean importance. when we consider that on it is founded and being reared up the greatest antagonistic heresy to the source of Englands greatness that history has on record. An important question may truly be asked. Was Copernicus the Anti-Christ. ? The question is worthy of your careful consideration. and even refutation if its in your power to do so. the question may surprise you. and well it may. when you consider the marvellous rapidity with which the supposition theory have spread itself over the face of the whole civilised world.

It has come in the latter days. with haste. even as a cloud covering the whole land with gross spiritual darkness. It has risen out of the sea pure and simple. it requires no mystifying of the text to prove its truth. It is in direct antagonism to the Spirit of the Bible from Genesis to Revelation. It have extended its influence over the whole civilised world. It have made rich many merchants of the earth. It have made war with the Saints and overcome them. Its advocates are constantly conjecturing something contrary to their predecessors. and publicly exposing their suppositions to be what they really were. hypothetical suppositions and nothing more.

The foregoing characteristics are essentially the unmistakable prophetic characteristics of the Anti-Christ. and his numerous followers. they really agree in nothing except in trying to prove the Bible untrue. their suppositions is in reality as unmixable as iron and clay. The theory presents mysteries greater than any other known invention under the Sun. Therefore. I am open to prove in any paper you may name. that the theory is a delusion from three seperate positions. First. from the Bible. Second. from the provable Level surface of the sea. and Third from the provable distance of the sun from the earth by Architectural measurements on the unerring triangulation principle. and I hereby challenge you or any other man to produce proofs (in the same paper) in favour of the theory First from the Bible. Second. from the convex surface of the sea. and then produce your proofs that the Sun is 3 million or 95 million miles distant from the earth. which of the two distances you may imagine has the greatest number of substantial proofs. and in honour of Truth let the winner of the challenge be the one who has the greatest number of substantial proofs in two out of the three suggested positions. an early answer will oblidge Yours Resptly. WM. HARDY.

St. Helens. Isle. of. Wight.

[It will be shown next, I suppose, that in KNOWLEDGE with its far-wandering editor, sub-editor, and staff, its motto "Let KNOWLEDGE grow from more to more," and its monthly increase, there is clear evidence of the approach of those latter days when, we are told, "men shall run to and fro and Knowledge shall be increased." —R. P.]

"Let Knowledge grow from more to more."—ALFRED TENNYSON.

Only a small proportion of Letters received can possibly be inserted. Correspondents must not be offended, therefore, should their letters not appear.

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DRESS REFORM (CORRECTIONS).

SIR,—May I ask you kindly to allow me to fill up two omissions in my article on "Dress Reform." The first occurs in the quotation from my lecture. Between "decked out in beautiful colours," and "to which it has no claim," should be "which has given it a pretension to beauty."

The second omission makes the continuation of my paper almost unintelligible, as the argument chiefly hinges on the words left out. The 5th requirement, as laid down in the circular of the Association is, "not departing too conspicuously from the ordinary dress

of the time." The omission of the words "too conspicuously" completely alters the meaning of the sentence. E. M. King.

[We gladly give Mrs. King's letter insertion. The omission of the words was due to a printer's error.—R. P.]

OLDEST HISTORICAL TREE.

[891]—In answer to "Cosmopolitan," the Bodhi tree at Anaradhapuree, Ceylon, is the oldest *historical* tree in the world—not the *oldest tree*. That at Buddh Gaya, near Gaya, from which it was taken, was destroyed, and two or three of its successors also destroyed. The first destruction took place under the orders of Asoka's Queen. The present tree is quite young. I send you herewith a printed account of my visit to it two years ago.

K. S. Macdonald.

LETTERS RECEIVED, AND SHORT ANSWERS.

M. Doubleday. Evil all the time, is there not?—R. Thomson. It would be difficult to say what the capsizing influence of the current would be on a ship launched as the *Daphne* was.—S. J. Potter. Foretelling destiny by aid of planets sheer nonsense now-a-days, but a not unreasonable notion in old times; the most respectable of the old superstitions.—R. F. Kerr. If I could define that word, I should know something indeed. "Can'st thou by searching," &c., they said in old times; so must all say, throughout all time.—E. B. would be obliged if "Pédestrienne," through Knowledge, would say where the pattern she speaks of, with instructions for making up, can be obtained.—Z. I should say, and so says the writer of the articles in question, a manifest swindle. You will find no chemist to make up the prescription sent you, so must send to advertiser, who charges an exorbitant sum, for a draught possibly worthless, but most probably exceedingly harmful.—W. Woods Smyth. *Does* Mr. Herbert Spencer's rule for moral action enjoin us to seek our own happiness supremely? You astound me! *I* thought there was precisely that principle of equilibration in his system of ethics which there is in his system of philosophy generally. Really he seems to say so. But perhaps he does not know his own meaning. Let us wait to see what Mr. Foster makes of it. *Only*, frankly, if Mr. Foster should work out your result, or anything so remote from Mr. Spencer's own teaching, the editor will interfere in a very summary manner with his friend Mr. Foster's series of papers. This is not likely, though.—Thos. Westlake. Out of your own mouth (or from your own pen) you shall be judged. "When will men see," you ask, that there are two revelations of God, one in his works, and the other in his Word? We cannot perhaps always see at once how they harmonise. But we answer they *do*, and we shall by-and-by know how." Yet you are sorry that a series of articles should appear in these pages, the object of which is in the main, as I understand Mr. Foster's purpose, to show that practically the same moral laws result from natural processes affecting the condition and progress of God's work—man—which have been enunciated in those works which you regard as His word. Your contention is unreasonable.—E. C. H. I had the pleasure of conversing with several representative members of the Worthing audience, and think you are mistaken. Friends who were in the audience think so too. Though of course there were many there of the class you mention.—G. S. Question considered.—Leonard Brown. Shelley there obviously attacks the argument from design, but his suggestion of the line of reasoning followed later by Mr. Herbert Spencer (the real originator of the environment doctrine) is too vague to be regarded as an anticipation.—J. Russell, B.A. Question does not admit of a solution as stated.—Inquirer. Two or three months ago the problem of 21 school-girls was solved in a systematic way; easily extended to the case of 15. The problem is not in any case a simple one.—E. Barton. Certainly hope to give a course of six evening lectures in Manchester before I leave England.—W. H. B. Ranine(?). I believe the flat earth men have no knowledge of what has been done in the way of Antarctic exploration.—C. Thompson. An instrument for assisting the hearing was invented by a Chicagoan a few years ago; it was a tantened surface of card or tin, japanned, and held by a handle with the middle of the outer edge between the teeth. As nearly as I can remember, it was about as large as a medium-sized fan. Possibly some reader may be able to give an account of it.—E. W. Tawom (?). Thanks; but the conjuring trick rather complex.—H. C. Jones. In that sense I am already a member of your "Society for correcting, detecting, and where necessary exposing slander." Much obliged for your very kind remarks about my Southampton lectures, and your report of the kindly acceptance they met with from your friends. We lecturers are supposed to be so possessed with the sense of our constant rightness, and the eternal fitness of all we say and do, that we ought not to hear of any kindly things said of us,—whereas as a matter of fact we are a race of "nervous, shy, low-spoken men" like the Coxswain of the "Mantelpiece," and "not to be treated unbenignly" as Tennyson puts it.—C. J. R. Richards. Those who often tell you that geology disproves evolution because in the lowest fossiliferous rocks animals of a higher organisation have been found than in the upper rocks, should often study a little geology. The statement is untrue in every sense except thus far that just as at the present time there co-exist higher and lower organisations, so has it been in past times; and some of the organisations of an older epoch are necessarily higher than some of the organisations of a later one, even of the latest of all, the present.—A Student. Quite unable to answer such questions; it would afford a bad precedent, and moreover lead to a great deal of annoyance.—Hugh Clements. "Great earth dominating planets." Great earth dominating fiddlesticks!—J. W. C. "Say about one inch apart,"—all right, I say that: but I do not say what the power of your telescope is. Seriously, one such question answered here would bring a hundred; each of these many more, and of Knowledge would be killed by kindness—its editor's.—H. T. Perry. Thanks: but matter hardly important enough to be re-opened.—J. Greeves Fisher. Yes: but your account of the puzzle does not tell us what would happen if some other number than "one" were thought of.—S. M. B. It should be tolerably obvious that Mr. Ledger and I both made the same blunder, speaking of the day as shortening instead of lengthening, though elsewhere we had each carefully shown that it is lengthening, and how, and why.

Our Mathematical Column.

GEOMETRICAL PROBLEMS.

By Richard A. Proctor.

PART X.

Let us next try a problem which is the converse of Example 5.

Ex. 13.—*To determine the greatest of all the triangles which can be constructed upon a given base and with a given perimeter.*

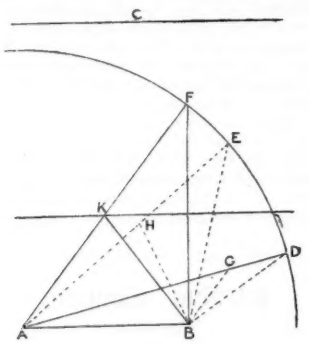

Fig. 21.

Let A B, Fig. 21, be the given base, C the sum of the remaining two sides.

Now, with a knowledge of the property established in Ex. 5, it is of course very easy to see what is the solution of our problem. But we shall assume that the student is dealing with the problem independently. With centre A and radius equal to C describe the arc D E F, and draw radii A D, A E, and A F. Then if from B we draw lines B G, B H, B K in such a way that B G is equal to G D, B H to H E, and B K to K F, it is obvious that each of the triangles A G B, A H B, A K B has the required perimeter. Now it is an obvious consideration that if B G is equal to G D the angle G B D is equal to the angle G D B (we here draw in B D) and, therefore, that in order to draw B G so as to be equal to G D, we have only to make the angle D B G equal to the angle G D B. So that having a *construction* for determining any number of triangles, it is presumable that we shall find materials for determining the triangle of maximum area. But first let us see if anything is suggested by an examination of the figure. We see first that the triangle gradually increases as the angle at A increases. But there is clearly a limit to this increase. For it is obvious that we might have taken B as the centre of a circle with radius C, and thus have shown that the triangle increases as the angle at B increases. We

are led, therefore, at once to the consideration that our triangle will have its greatest area when the angles at A and B are equal.

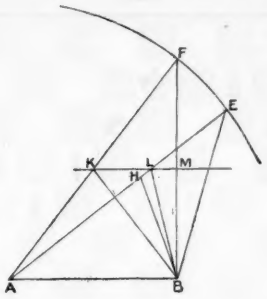

Fig. 22.

To see whether this is the case, we construct a new figure (Fig. 22), in which we omit all unnecessary parts of the former figure, and draw A K F, so that when the triangle A K B is completed, the angle K A B shall be equal to the angle K B A. We then draw K L M parallel to A B, knowing that it is on the distance of this parallel from A B that the area of the triangle A K B depends. We take A E pretty near to A F (seeing that the triangle has obviously *nearly* a maximum area when the angles at A and B are equal, so that any great departure from equality makes the triangle considerably smaller). Let A E intersect K L M in L. Then, if we can show that B H, drawn as before, falls between B A and B L, our surmise will have been proved to be correct. Now the angle H B E, by our construction, is equal to the angle H E B, therefore we must show that the angle L B E is less than the angle L E B, or L E less than L B (Euc. I., 19); therefore, adding A L, we have to show that A E (or C) is less than A L, L B together. This is the problem dealt with in Example 5, and thus the rest of the work corresponds with the work in that example. We find that A L and L B are together greater than A E, so that H *does* fall below L; and the triangle A K B is greater than the triangle A H B. Our surmise is, therefore, shown to be correct, and the problem is solved.

It will be noticed that a problem in maxima and minima loses a large part of its difficulty when, as is usually the case, we are merely asked to prove that such and such relations supply a maximum or a minimum. In the case of Example 13, indeed, inspection supplied a tolerably obvious solution, but this seldom happens. Presented in the usual form, the above problem would run.

Of all triangles on a given base, and having a given perimeter, the isosceles triangle is the greatest.

Thus given, the problem reduces immediately to the case of Example 5.

Example 13 fitly introduces the following, which belongs to a class often found perplexing:—

Example 14.—*Of all triangles having a given perimeter, the equilateral triangle is the greatest.*

The difficulty in a problem of this sort resides in the fact that we have three elements to consider, all of which admit of being changed. In Example 13 we only had two sides to consider, and when a length had been selected for one, the other was determined at the same time. In Example 14 we have three sides, and must assign lengths to two before the final condition of the triangle is determined. This would be found to afford no assistance towards the solution of the problem. The way to proceed is to assign a length to one side, provisionally, and then to consider what relation must hold between the two remaining sides, whose sum is now assigned,

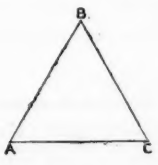

Fig. 23.

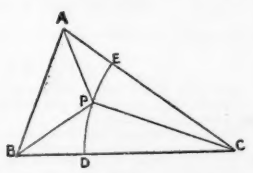

Fig. 24.

in order that the triangle may be as large as possible. This we have learned already from Example 13. Those two sides must be equal. Hence, whatever side we suppose assigned, the remaining two must be equal, to make the area of the triangle a maximum. Therefore, obviously, the triangle must be equilateral. The proof of this would run as follows:—

Let A B C (Fig. 23) be the triangle having the greatest possible area with a given perimeter. Then A B C must be the greatest possible triangle on a given base B C and with the sum of the remaining sides equal to the sum of B A and A C. Hence B A is equal to A C. But also, A B C is the greatest triangle on the base A B with the given perimeter; hence, as before, A C is equal to B C. Therefore A B, B C, and C A are all equal.

As another instance of the application of this important method, we give the following:—

Example 15.—*A B C* (*Fig.* 24) *is an acute-angled triangle. It is required to determine the position of a point P within the triangle, such that the sum of the distances P A, P B, P C, shall be a minimum.*

Assume P to be the required point. Then P A, P B, and P C together have a minimum value. Therefore, also, P A and P B have the least sum they can have *so long as the length of P C remains unchanged:* so that if we draw the arc D P E with radius C P and centre C, A P and P B are together less than the sum of any two lines which can be drawn from A and B to meet on the arc D P E. Hence (Example 11, Cor.), A P and P B are equally inclined to C P. Similarly A P and P C are equally inclined to B P. Hence the angles A P B, B P C, and C P A are all equal, and each, therefore, is one-third part of four right angles.

Our Chess Column.

By Mephisto.

SCORE OF THE NUREMBERG INTERNATIONAL TOURNAMENT, ON SATURDAY THE 28TH JULY, 1883.

Names.	Bardeleben	Berger	Bier	Bird	Blackburne	Fritz	Gunsberg	Hruby	Lange	Leffmann	Mason	L. Paulsen	W. Paulsen	Riemann	Schallopp	Schottländer	J. Schwarz	Weiss	Winawer	Total score
Bardeleben	—	1	1	0	½		1	0	1	1	½	½	1		0	½	1	½	0	9½
Berger	0	—	1	½	½	½	1	½	1	1	½	½	½	½		½	1	1	0	10½
Bier	0	0	—	0	0	½	1	½	1	1	0	0	1	0	½	1	1	½	0	8
Bird	1	½	1	—	0	½		1	1	1	0	1	1	1	0	0	½	1	0	10
Blackburne	½	½	1	1	—	1		1	1	1	½	0	1	1	0	½	1	1	1	12½
Fritz		½	½	½	0	—	0	0	0	½	1	½	1	0	1	0	0	0	0	5½
Gunsberg	0	0	0	½		1	—	0	0	1	0	0	1	0	0	0	½	0	1	5
Hruby	1	½	½	0	0	1	1	—	0	1	½	½	½		0	½	½	½	0	8
Lange	0	0	0	0	0	1	1	1	—	1	0	0	0	½	0	½	0	0	0	5
Leffmann	0	0	0		½	½	0	0	0	—	0	1	0	0	0	½	0	½	½	3½
Mason	½	½	1	1	1	0	1	½	1	1	—	1	½	½	½	1	½	½	0	12
L. Paulsen	½	½	1	0	½	½	1	½	1	0	0	—		0	0	½	0	1	0	7
W. Paulsen	0	½	0	0	0	0	0	½	1	1	½		—	0	1	1	½	½	0	6½
Riemann		½	1	0	0	1	1		½	1	½	1	1	—	1	½	0	½	½	10
Schallopp	1		½	1	1	0	1	1	1	1	½	1	0	0	—	0	0	1	0	10
Schottländ'r	½		0	1	½	1	1	½	½	0	½	0	½	1	—	½	0	0	0	8½
J. Schwarz	0	0	0	½	0	1	½	½	1	½	1	½	1	1	½	—	½			9½
Weiss	½	0	½	0	0	1	1	½	1	½	1	½	½	0	1	½	—		1	9
Winawer	1	1	1	1	0	1	0	1	1	1	1	1	½	1	1		0	—		13

As will be seen from the score table published, this great tournament is all but concluded, Winawer being at the head of the list, and Blackburne and Mason following close behind. To speak of Winawer's play as being absolute best would be doing injustice to Blackburne, than whom none in this Tournament have played finer games—a fact acknowledged by all other competitors. Winawer, however, is fond of originality. He generally avoids the known openings by playing P to Q3. As second player he also developes great resources in difficulties. As a notable instance of this may be cited his game with Hruby, one of the most complicated games in the Tournament. At the adjournment the position stood very unfavourably for Winawer, in spite of his being a rook to the good, and it was the general impression that he would lose. Nevertheless, he scored a comparatively easy victory.

Blackburne, who defeated Winawer, has played several games in which, for powerless play in one given position, he has played in matchless style; but he has erred in some instances in judgment of position, which cost him the first prize, notably in his game with Mason, when he repeatedly avoided the draw in a position slightly in his favour, and finally lost. This is a quality in play which reflects credit upon him to the disadvantage of his score. The fact

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of his having made several draws is owing to the strength of his competitors, his last draw being with Schottländer, a young player who combines rapidity and ingenuity of combination with considerable experience in tournament play.

Mason has played carefully, the climax being reached on Saturday, when W. Paulsen began with 1. P to QB3, to which Mason replied with 1. P to K3, to the general amusement of the lookers on. The game ended in a draw. Mason and most of the other players favoured the early advent of the QB in the close games on the Queen side.

Bird has played some very fine games, notably one with Riemann, who has improved very much. Bird has, however, lost a game to Mason, in which he adopted his favourite defence to the close openings of P to KB4. In this game he had a superiority in the opening which, by careful play, ought to have enabled him to win the game.

Gunsberg in the first week's play scored 5, defeating Winawer amongst others. He, however, strange to say, entirely broke down in the second week, neither winning nor drawing a game, nor even making any considerable show of resistance, but falling an easy victim to his antagonists. A notable example is his game with Berger, in which, after a well-conducted attack, he missed victory when within easy reach.

The committee have been true to their promise, and rendered the stay of the players as pleasant as possible. Foremost amongst the entertainments provided was a special grand theatrical performance, given in honour of the chess-masters, in which a game with living pieces was played instead of a ballet. Every player will certainly keep in pleasant recollection the third congress of the German Chess Association at Nuremberg.

Nuremberg, July 30th.

The Tournament was concluded to-day by Winawer taking first prize, having defeated Schwarz; score 14. Blackburne, 13½, is second; beat Gunsberg. Mason, 12, third. Berger, 11½, beat Schallopp, is fourth. Bardeleben, 11, fifth, beat Fritz. Bird, 10½, and Riemann, 10½, are sixth and seventh. Schallopp, 10, is eighth; while Schwarz, 9½, takes ninth prize.

GAME BETWEEN BIRD AND RIEMANN, PLAYED JULY 28TH, 1883.

White (Bird).	Black (Riemann).	White (Bird).	Black (Riemann).
1. P to KB4	P to Q4	12. Q to K sq.	R to Q sq
2. P to K3	P to QB4	13. R to B sq.	B to Q3 (*b*)
3. Kt to KB3	Kt to QB3	14. Q to Kt3 (*c*)	R to KKt sq (*d*)
4. B to KB5	Q to Kt3	15. Kt takes P	P takes Kt
5. P to B4	P takes P (*a*)	16. B takes Kt	R to QR sq
6. B takes P	P to K3	17. QB tks QKtP	K to B sq
7. Kt to B3	Kt to B3	18. B to K5	R takes P
8. Castles	P to QR3	19. R takes P (*e*)	P to B3
9. P to QKt3	Q to B2	20. B takes Kt	P takes B (*f*)
10. B to Kt2	P to QKt4	21. P takes P	B takes R
11. B to K2	B to Kt2	22. Kt to Q4 (ch)	Resigns (*g*)

NOTES.

(*a*) This brings White's Bishop into good play; either P to QR3 or P to K3 was advisable.

(*b*) Having regard to the dangerous position of the White QB bearing on the KKt file, B to K2 would have been safer.

(*c*) A very good move, which prevents Black from Castling on account of Kt to K4.

(*d*) This, of course, loses on the move, but Black hardly had a satisfactory reply, excepting, perhaps, B to K2, followed by R to Kt sq if Q takes P.

(*e*) White plays in very fine style. Black cannot prevent the impending dissolution.

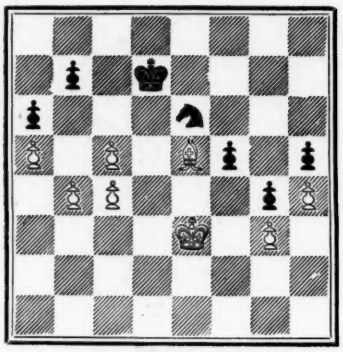
(*f*) If B takes B, then Kt to Q4 wins.

(*g*) A fine finish to this well-played game, if K to K2 then Q to Kt5, mate.

POSITION IN GAME BETWEEN BLACKBURNE AND WINAWER.

WINAWER.

BLACK.



WHITE.

BLACKBURNE.

The game proceeded with—

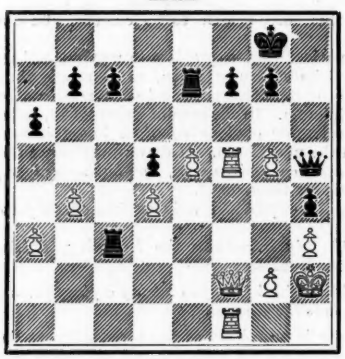
B to Kt8	K to B3
B to Q6	P to Kt4
RP takes P en pas.	K to Kt2
B to K7	P to B5 (ch.)
P takes P	P to Kt6
P to B5	Kt to Q5!
K takes Kt!	P to Kt7
K to Q5	Resigns

If P to Kt8 (Queen), P to B6 (ch). K takes P (best), B to B5 (ch) and wins.

POSITION IN A GAME BETWEEN SCHOTTLÄNDER AND SCHALLOPP.

SCHALLOPP.

BLACK.



WHITE.

SCHOTTLÄNDER.

In this position White played—

P to K6	P takes P
R to B8 (ch)	K to R2
Q to Q2	R to KKt6
Q to B2 (ch)	P to Kt3
Q to B2	Q takes P

Q to B7 (ch), mates in two moves.

CONTENTS OF No. 91.

	PAGE		PAGE
How to Get Strong: Reducing Fat	49	Sun-Views of the Earth. (*Illus.*) By R. A. Proctor	57
The Birth and Growth of Myth. XII. By Edward Clodd	50	Flight of a Missile	58
Spots on the Sun. By R. A. Proctor	51	Editorial Gossip	59
Chemistry of the Cereals. II. By William Jago, F.C.S.	52	Cholera (Preventive)	60
The Great Pyramid	53	Correspondence: Geometrical and Real Perspective—Skyers—Dress Reform—Short Answers to Letters Received, &c.	60
Principles of Dress Reform. By E. M. King	54	Our Mathematical Column: Geometrical Problems	62
The Moon in a Three-Inch Telescope (*Illus.*) By F.R.A.S.	56	Our Chess Column	63

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